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ABSTRACT

The studies reported in this paper provide evidence that the introduction of self-paced curriculum materials into learning environments where they had not been previously used produces changes in pupils' perceptions of their environments and in the manner in which these function, even when the teachers' beliefs about effective teaching are dissonant to the approach adopted by the materials. Three groups of Australian ninth-grade science teachers, and graduates undertaking the Diploma in Education, were studied, arranged according to their dissonant, consonant, or ambivalent attitudes toward the Australian Science Education Project (ASEP) curriculum units. These units, designed to foster inquiry by pupils, change the role of the teacher from that of an information disseminator to a resource person and emphasize that science is an integrated field of study, not just physics, chemistry, biology, geology, and astronomy. Observation of student-teacher classroom interaction and interpretation of student achievement and attitude data revealed that (1) a mismatch between the teacher's approach and that of the materials did not significantly disadvantage the student either cognitively or affectively; (2) added, teacher-developed structure improved student performance for all three groups, particularly in those classes where teachers did not value the ASEP approach; (3) while pupils' entry characteristics did not markedly affect their perceptions of the new learning environment, those who previously enjoyed the lessons and succeeded, continued to do so in the ASEP setting; (4) certain environmental variables (e.g., apathy, diversity, information-giving, rest periods) contributed to variations in achievement, while some of these, and others (e.g., cohesiveness, goal direction, friction, cliquishness, disorganization) contributed more to variations in attitude toward environmental issues than did the ASEP approach. (MJB)

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The effects of curriculum changes and teacher structuring on pupils' perceptions of Australian learning environments.

by

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Introduction

In Australia, especially during the last decade, there has been an increasing commitment by national and state education authorities, national curriculum agencies (e.g. the Curriculum Development Centre) and various teacher organisations to the notion of School Based Curriculum Development. The meaning of the term, and its practical outcomes, have however, various interpretations. In some instances authorities, schools and teachers have assumed that the term means each school, whether small or large, with few or many resources, should start from a tabula rasa and develop their own curricula, including necessary teacher and pupil materials, which meet local educational goals and needs - with many consequent traumas, and frustrations and emotional exhaustion. On the other hand, some groups, though not jettisoning the previous interpretation entirely, have assumed the term to imply the rational selection from an existing smorgasbord of curricula offerings with a subsequent adaptation of parts or wholes of these to meet local educational needs. The extent to which one or other of these views predominates in any Australian state or territory, or local educational region, depends on a subtle blend of educational, political, economic and sociological antecedents. During the period when the embryonic ideas of School Based Curriculum Development were being advocated Australia launched its first national curriculum effort - the Australian Science Education Project (ASEP) - which, among other things, was an attempt to stir the educational troglodytes. This endeavour, which extended over the years 1969 - 1973, produced 47 science curriculum units for grades 7 to 10 from which teachers could select any number to design a science course suited to local needs. The various units were designed to foster inquiry by pupils, change the role of the teacher from that of an information disseminator to a resource person and to emphasise that science was an integrated field of study, not just physics, chemistry, biology, geology and astronomy.

Although the ASEP designers intended teachers to select materials in accord with the second meaning for School Based Curriculum Development, it is intriguing to note that a variety of factors, including persons in positions of authority, played extremely significant roles in influencing the extent to which ASEP has, over the years, been disseminated, adopted and used in Australian schools. Whereas today one or more of these curriculum units are used in at least 60 per cent of Australian junior science classrooms the "density" of use varies across and between states. Furthermore, the use has, as was noted above, been affected by key personnel in the schools and larger education systems. These features have been documented by Owen (1977) in his national survey on the fate of the ASEP innovation.

So, despite the intentions of the ASEP design team which worked collaborately with selected Australian teachers, there are numbers of situations today where teachers who are not in accord with the "ASEP-tic" approach to science and science teaching, nevertheless, for a variety of influential reasons, are obliged to use some of the units. In this "mis-match" situation, will pupils be disadvantaged? If so, in what ways? But, then, given the situation with a teacher who is dissonant with the ASEP approach, do the curriculum units still affect the nature of the learning setting? These are some of the research questions that were asked by the authors when ASEP was initiated and they and the answers are vitally relevant today.

Concurrently with the school based curriculum movement there has also been a continuing commitment in varying degrees to "open education" and concomitant styles of teaching which, it has been averred, are more appropriate for a greater variety of pupils. Admittedly "open education" and its concomitant teaching styles are variously interpreted, but in one sense the ASEP units, with their intention to foster pupil inquiry, approach an "open education" concomitant teaching style. Perhaps a more appropriate description is that the units favour self-pacing, that is, an approach which may be designated "doing our thing in your own time", with some choice of options. Each ASEP unit contains a core of material which all pupils follow, but then, they are encouraged to choose among a number of options which extend the ideas in the core. The options are designed to cater for different interests, ability and reading levels, and rates of working. But, at this present moment, in Australia, as elsewhere, open education and self-paced learning environments are being subject to critical scrutiny. Fuel has been added to the fires of argument by research reports like that of Neville Bennett (1976) despite some incisive criticisms of his work (Selleck,1976). So it is essential to obtain as much information as possible on how these environments function and what pupils' views are about them. Also, it is essential to discover what impact various adjustments to these environments have, for only then can we indicate how to vary them for maximum educational gain. For example, if Bernsteins (1971) arguments relating to closed and integrated forms of knowledge and weak and strong framing are accepted, it may be expected that the ASEP materials will constitute a challenge in some settings where strong framing and closed forms of knowledge are valued. But then, the addition of some framing (or structuring) in some settings may make ASEP more appealing and consequently enhance its effect. These issues and the preceding questions were among the research queries which became the foci of a series of studies carried out at the University of Queensland and subsequently at Monash University. Although the projects began at a time when ASEP was being launched the questions guiding

the studies are extremely relevant today.

2. Methodology and Research Questions

The research questions germane to the research endeavour referred to have been mentioned above but any attempt to answer them must take account of the teachers' educational values as well as the characteristics of individual pupils and the class as a group. This was in fact done. This paper, however, will not deal with them all and for additional details reference can be made elsewhere (Tisher and Power, 1973; 1975 a & b; 1978). The focus here will be on the following questions:

* "What impact do the ASEP curriculum materials have in learning environments where teachers are in accord or not with the ASEP approach?"
* "What occurs in these environments when different amounts of structure are superimposed on them? In particular, what is the effect on unit outcomes of varying the amount and location of structure in the materials and in teaching?"
* "What are some of the relationships between key variables such as behaviours, perceptions and outcomes? In particular, in the ASEP classrooms, what are some of the relationships between pupils' entry characteristics and their perceptions of the environment, and between environmental measures and outcomes?"

In this research two ASEP units were used to give direction to classroom activities. Although the ASEP units generally have much in common, they differ in the extent to which they foster cognitive or socio-affective outcomes, or are convergent or divergent. Furthermore, units differ in their degree of specificity and in the structure within the materials. The units chosen reflected these differences. One, "Light Forms Images", is a structured Physics unit designed to foster understanding of the principles of optics whereas, the other, "How Many People" is less concerned with content mastery but more with creating an awareness of, and concern for problems associated with population growth and environmental conservation. "How Many People" was used in one study (Tisher and Power,1975a) and "Light Forms Images" in an earlier one (Tisher and Power, 1973). In the first study pupils' perceptions of the learning environment were obtained using the CAQ (i.e. Class Activities Questionnaire; Steele, House and Kerins, 1971) as a post-test. A principal components analysis and a varimax rotation using the data produced eight components accounting for 54.6 per cent of the variance. These were named and used as the scales in subsequent analyses. Further details appear in Table I. In the second study the CAQ along with the LEI (i.e. Learning Environment Inventory; Anderson, 1971) were administered

TABLE I

COMPONENT ANALYSIS OF THE CLASS ACTIVITIES QUESTIONNAIRE

Component & percent of variance	Item numbers, key words and varimax loadings.	Factor Number & Loading (Illinois data)
I. Independent Inquiry (10.4)	44. Independently explore (.69)	I (.57)
	47. Discover many solutions (.65)	(not reported)
	53. Invent, design, compose (.64)	I (.71)
	48. Ideas more important than grades (.61)	(excluded)
	43. Practice skills in problem solving (.50)	I (.45)
	49. Excited and involved in class (.48)	IV (-.65)
II. Indifference (5.8)	54. Do not enjoy ideas studied (.72)	(excluded)
	45. Little opportunity for participation (.59)	IV (.69)
III. Humour (5.4)	55. Little joking or laughing (.72)	VI (.96)
	32. Make judgments of good/bad (-.46)	IX (.83)
IV. Cramming (7.7)	52. Great concern for grades (.68)	II (.64)
	40. Emphasis on memorizing (.62)	II (.73)
	65. (Amount of) Teacher Talk (.63)	(excluded)
	42. Thinking through complicated problems (.42)	V (.72)
	34. Do other things than listening (-.40)	VIII (.93)
V. Interpretation (6.5)	36. Go beyond information given (.74)	III (0.71)
	46. Find trends and consequences (.61)	III (-.80)
	41. Build to produce something new (.42)	I (.64)
VI. Participation (5.5)	35. Actively participate in discussion (.69)	IV (-.78)
	45. Little opportunity for discussion (-.33)	IV (.69)
VII. Translation (7.1)	39. Restate ideas (.60)	VII (-.80)
	51. Explaining and summarizing (.65)	VII (-.45)
	38. Know the one best answer (.44)	II (.64)
	50. Judge the value of ideas (.45)	X (.69)
VIII. Information Processing (6.3)	33. Put methods and ideas to use (.65)	I (.56)
	31. Remember information (.61)	II (.53)
	37. Logical reasoning and analysis (.52)	V (.73)

Note: Three additional scales (3 items each) were used to assess the extent to which pupils perceived that they were involved in class, initiated activities, and had a teacher who was concerned about them.

as pre and post-tests. Some slight adjustments were made to the LEI to make its phrases relevant for Australian pupils and each scale was reduced from seven to six items. The scales items and respective reliabilities appear in an earlier technical report (Tisher and Power, 1975 a). In addition to the preceding instruments attitude and achievement pre-tests were administered before the teaching of a unit began, and attitude and achievement post-tests appropriate to the objectives of the unit were administered when the pupils had completed the core section.

A total of 41 persons, fourteen experienced grade 9 science teachers and 27 science graduates undertaking the Diploma in Education at the University of Queensland, were selected to participate in the studies. They were carefully chosen to ensure they were representative of different value positions about the nature of effective teaching. To determine what these value positions were a modified Teaching Practices Questionnaire (Adams, 1970) and the Teacher Opinions Scale (ASEP, 1973) were administered to 110 Brisbane science teachers, 151 science graduates in the Diploma in Education programme, and 16 ASEP staff. The data were analysed using a principal components procedure followed by a varimax rotation using an eigen value cut-off of 1.0. Factor scores for each individual on eleven extracted factors (accounting for 58% of the varimax) were then used in an hierarchical grouping analysis (Veldman, 1967). This technique established clusters of individuals whose expressed values, based on a combination of the eleven scales measuring beliefs about teaching and curriculum, were similar. Multiple discriminant analysis procedures were then used to determine the manner in which the clusters actually differed. Complete details of the procedures and results appear in earlier technical reports (Tisher and Power, 1973, 1975A). Essentially three basic clusters of individuals were identified and it is intriguing to note that six of the ASEP staff were not classified into the third group named below. The three basic clusters were designated as follows:

Group I: those who were <u>dissonant</u> to ASEP's expressed style of teaching.

This group believe that a whole class, not small groups of pupils, should work together on an activity and that pupils should not devise or conduct their own experiments. They also believe that the teacher should be dominant in class, managing, controlling, disciplining, demonstrating and dispensing all the necessary scientific information.

Group II: those who were in a <u>mixed mode</u> with respect to ASEP.

This group has some of the beliefs which characterise Group I but they also share some of those which characterise persons

who value an ASEP style approach (i.e. Group III below). For example, they value supportive personal relationships between teacher and pupils, communication between all members in a class, and the inclusion of a broad range of scientific subject matter. But, they also believe that the teacher should be dominant in class, managing, controlling, disciplining, demonstrating and dispensing all the necessary scientific information.

Group III: those whose values were congruent with respect to ASEP's expressed approach.

Persons in this group value supportive personal relationships between teacher and pupils, communication between all members in a school class, and the inclusion of a broad range of scientific subject matter. They also believe that pupils should have first hand experience with phenomena, and should devise and conduct their own experiments, preferably in small groups. Consequently they maintain that the teacher should not be the major dispenser of scientific information nor a dominant disciplinarian or controller of activities.

The individuals selected were close to the group centroids within each cluster. Twenty-one were asked to teach the core section of "Light Forms Images" and twenty the core of "How Many People". The experienced teachers remained with their Grade 9 science classes whereas the classes of the trainees in the Diploma in Education comprised ten to twelve randomly selected Grade 9 pupils from their training schools. Approximately half of the lessons required to teach a core section were videotaped and the tapes were analysed using a coding scheme, SABIC, designed especially for the project (Tisher and Power, 1975a). SABIC, a Scheme for Analysing Behaviour in Individualised Classrooms, is a 40 category multiple coding system. Events are coded every 10 seconds according to the source of a message or act, the target, what the activity was in which the source was engaged, and the function of the act. A pupil, a group, the class, the teacher and materials are included in the source and target categories. Questioning, direction-giving, information-giving, reading, writing, observing, and experimenting are examples of activities. The functions are sub-divided into intellectual (e.g. fact-stating, explaining), instructional (e.g. discussion of procedures), affective (e.g. praise or positive affect), and non-instructional ones (e.g. task-irrelevant activity). Thus an event in which a pupil asked the teacher to interpret the meaning of a substantive statement would be coded as "pupil-teacher-question-interpreting".

In each of the studies certain treatments were coupled with the introduction of ASEP into the various classes. In the first the amount of structuring was varied in fifteen classes, whereas in the second its location in the teaching sequence was altered in twelve. The experimental teachers had not previously used ASEP with their pupils and all underwent a short training to familiarise them with the unit and to help them with the structuring activities. In the first study the basic treatments were as follows:

Treatment 1: Additional Structuring

Under this treatment the classes used the ASEP pupils' guide, record book and ancillary equipment, but, at salient points in the sequence of lessons the teacher involved them in either a review of what had been done, or an overview of what was to come.

Treatment 2: ASEP Materials Only

The classes under this treatment used the ASEP materials as did those under treatment 1, but in this case, there was no additional structuring by the teacher. Pupil activities were guided by the instructions in the materials and the teacher acted as a resource person providing stimulation and feedback as the occasion required.

Treatment 3: Unstructured

Under this treatment the classes were provided with all the necessary equipment and aids to study the concepts contained in "Light Forms Images" but not with the pupils' guide or record book. The pupils were encouraged to devise their own experiments from a rich learning environment while the teacher acted as a resource and guide.

In the second study, teachers with different value orientations were, similarly to the first, assigned to one of the treatments which in this case were:

Treatment 1: ASEP Materials Only

The classes under this treatment used the ASEP materials but there was no additional structuring by the teacher. Pupil activities were guided by the instructions in the materials and the teacher acted as a resource person providing stimulation and feedback as the occasion required.

Treatment 2: Pre-Structuring

Under this treatment the classes emulated those under Treatment 1 with one exception: in their first lesson the teacher presented an overview to highlight the basic ideas developed in

the unit and the BSCS film, "Population Ecology" was shown to facilitate the development of the concepts which would be met subsequently. (Together the two strategies act as advance organisers).

Treatment 3: Mid-Structuring

This treatment is identical to Treatment 2 except that the structuring (film and overview) was relocated to occur in the middle lesson in the sequence.

Treatment 3: Post-Structuring

As the name implies the structuring was located in the last lesson to act as a post organizer or a review. In other respects the treatment was as for Treatment 2.

For both studies observational data indicated that the training programmes had been effective and that the treatments were applied as designed.

A number of statistical procedures were used to analyse the data. In addition to the factor analyses, H-grouping and discriment analyses referred to above, product-moment correlation, analysis of co-variance, MANOVA, canonical correlation and multiple regression techniques were included. At appropriate stages in the discussion there are references to the techniques employed.

3. Results and Interpretations

(a) Impact of the curriculum materials

At the risk of oversimplification the answers to the first research question will be reported briefly. The coding of the videotapes provided data which indicate that the overall patterns of interactions within the classes using different ASEP units were remarkably similar (Tisher and Power, 1978). The classrooms were characterised by high levels of pupil activity with the pupils as the source and the target of most interactions. The types of activities occurring as well as the functions of these were also similar, with one notable exception. The pupils following "Light Forms Images" were involved in much more experimentation than those using "How Many People" where the pupils engaged more in discussions in small groups and in the exchange of ideas. This difference is due to the different characteristics of the units and, clearly then, these ASEP units operate as important determinants of classroom behaviours. This claim was substantiated further when the overall behaviour patterns were compared with those observed in an earlier study involving conventional science classes (Power, 1971).

With the classes using "How Many People" the LEI and CAQ pre and post-tests revealed some intriguing changes. Compared with their conventional science lessons prior to using ASEP, the pupils perceived the new learning

environment to be characterised by a greater cohesiveness amongst them as well as more diversity of interests, greater clarity regarding expectations and a lesson's goals, and more participation, satisfaction and enjoyment by pupils. They recorded that although there was a tendency for pupils to form cliques, there was less teacher favouritism, and pressure to hurry through tasks, as well as less confusion and disorganization, and pupil apathy.

These two sets of evidence together show that not only did the ASEP materials produce profound changes in classroom interaction patterns but in the ways in which the pupils perceived the learning environment. That is the overall picture. However, the ASEP materials, while affecting the environment, do not hold absolute sway. Teachers were found to use the materials in different ways depending on what they believed to represent good teaching. Significant product moment correlations were found between the observed behaviour categories and the teacher belief scales. To illustrate: in those classes where the teachers place a premium on discipline and rules and in controlling activities, there were fewer group situations for activities, more follow-up questions, more occasions involving writing and more involving the discussion of the progress being made in the task. Then in those classes taught by teachers who valued an inquiry-centred approach to science teaching, both pupils and teachers were more actively and intimately involved in the lessons and in the process of inquiry.

It may well be asked are pupils clearly cognitively or affectively disadvantaged when they are in classes where there is a mis match between the teacher's values and those on which the curriculum is based? A previous examination of the findings from the study on "Light Forms Images" indicates, "no" (Tisher and Power, 1975 b). Given comparable situations, apart from the value differences, the classes of the "mismatch" teachers did not lose out significantly either cognitively or affectively compared to those classes where there was a congruence between the teacher's values and that espoused by ASEP. However, the situation is more complex than this as the following sections will show.

(b) The effects of altering the amount and location of structuring.

As indicated in the section on methodology the question of how much structure was needed to facilitate achievement and satisfaction within an ASEP unit was examined using three experimental treatments with teachers of different educational values using the unit "Light Forms Images" (Tisher and Power, 1973; 1975 b). The data from the achievement and attitude testings were analysed using an analysis of covariance with unequal cell frequencies. Pre-test scores were used as the covariate and the treatments

and values were assumed to be fixed effects. The computer programme which was employed performed an unweighted-means analysis of covariance which is based on the computational formulae presented by Winer (1962, p.243 and 598).

The results indicated that as far as achievement gains were concerned, the performance of pupils under Treatment 1 (Additional Structuring) was superior to that under Treatment 2 (ASEP Materials Only) and, on the average, the performances under these two treatments were superior to that under Treatment 3 (Unstructured). The analyses also indicated that a moderate amount of teacher structuring, especially by those teachers whose educational values were not entirely congruent with the ASEP approach, did facilitate achievement on tests designed to measure this. On the other hand, pupils whose teachers' values were congruent with the ASEP approach performed less well on the criterion-referenced achievement tests when they "diverged considerably" (Treatment 3) from the ASEP Materials.

With respect to changes in pupil attitudes, the pupils appreciated additional structuring (Treatment 1) by the teachers when their values were more congruent with those of ASEP. But, then on the other hand, pupils who were taught by teachers with a more traditional orientation toward teaching (dissonant to ASEP) enjoyed the unstructured situation (Treatment 3) more than the structured ones. It appeared that a balancing mechanism was operating, counteracting the effects of extreme positions. Thus, the question of how much structure to build into a curriculum unit, or into classroom activities, is not a simple one - nor is the solution simple. It will depend upon an intermix and relative importance attached to achievement of the curriculum's cognitive objectives, teachers' educational values and, undoubtedly, by no means least, pupils' preference for structure.

The second question relating to the temporal locus of structuring was examined using four experimental treatments with teachers of different educational values using the unit "How Many People". The particular pre-test measures used as co-variates here were:

1. Inter D Scholastic Aptitude
2. Understanding of ecological concepts.
3. Understanding of population ecology.
4. Attitudes towards pollution issues.
5. Attitudes towards population control.
6. Attitudes towards resource utilization.
7. Interest in science lessons,

while the post-test measures included:

8. Understanding of ecological concepts (Ach. 1)
9. Understanding of population ecology. (Ach. 2)
10. Attitudes towards pollution issues (Attit. 1)

11. Attitudes towards population control (Attit. 2)
12. Attitudes towards resource utilization (Attit. 3)
13. Interest in ASEP science lessons (Satis. 1)
14. Perceived amount of learning (Satis. 2)
15. Satisfaction with organizational context (Satis. 3)

A 3 x 4 multivariate analysis of variance (values x treatment) with the 15 Learning Environment Inventory scales as the dependent variables was used to examine the effects of the experimental treatments of structuring, teacher values, and their interaction on the social climate of learning. This was considered an appropriate procedure since MANOVA not only provides separate tests for the contribution of each effect to each dependent variable, but also tests of overall concomitant effects on all variables considered simultaneously. Teacher values were entered into the design first in order to provide the most conservative test possible for the experimental effects. The overall results of the significance tests are summarised in Table 2. which indicates that all effects were statistically significant. In effect these results state that each mean can be explained only as a function unique to the particular group, i.e. the best prediction of the mean for a group is the observed values. To assist with the interpretation of these findings the univariate F statistics (Table 3) were used. These show that the interaction effect applies largely to formality, environment, friction, disorganization and apathy. When the estimated means (combined across sub-classes) and treatment by values interactions were calculated the results indicated that the interaction was ordinal and that the main effects reveal a consistent trend for many of the dependent variables. Figures 1 and 2 show the results obtained for the cases involving disorganization and formality, and are presented as illustrations of what occurred for many of the other variables.

The pupils allocated to the ASEP-only treatment perceived their classrooms as more disorganised, with more apathetic pupils and greater friction but less formality and not as rich an environment than those allocated to groups where structuring occurred. The post-structuring groups were clearly distinct from the ASEP-only ones, with the effects for the mid-structuring ones being intermediate between these two. Assignment to a class taught by an ASEP dissonant teacher resulted in pupils perceiving the class as less disorganised, less apathetic, more formal and with a richer environment containing less friction than being in a class with an ASEP congruent or mixed mode teacher. The preceding interpretation was confirmed by a series of multiple discriminant analyses to determine combinations of variables which maximally discriminate among groups.

The results indicate clearly that when there is no additional

TABLE 2.

Summary of MANOVA results for Values x Treatments design with LEI scales as dependent variables.

Source of Variation	Degrees of Freedom	Multivariate F F ratio (df)	Probability
Constant	1	-	-
Values, eliminating constant	2	2.98(30,210)	.0001
Treatments, eliminating constant & values	3	4.59(45,312)	.0001
Interaction, eliminating all the above	6	1.66(90,597)	.001
Among means	12		
Within groups	119		

TABLE 3.

Summary of ANOVA results for Values x Treatments design with LEI scales as dependent variables.

Scale	F - ratio		
	Values (2/119)[a]	Treatments (3/119)	Interaction (6/119)
Cohesiveness	1.52	2.97*	.60
Diversity	3.01	.76	.51
Formality	3.50*	5.15*	3.51*
Speed	3.98*	3.04*	.81
Environment	7.89**	10.96**	4.13**
Friction	19.35**	25.33**	4.03**
Goal direction	3.03	9.42**	2.05
Favouritism	3.47*	10.35**	1.40
Cliqueness	6.30**	6.94**	.58
Satisfaction	2.80	9.12**	.43
Disorganization	7.78**	12.76**	3.24**
Difficulty	.52	1.76	1.09
Apathy	5.46**	6.03**	2.59*
Democratic	4.09*	.38	2.05
Competitive	2.32	.77	.72

* $p < 0.05$

** $p < 0.01$

a: degrees of freedom shown in brackets

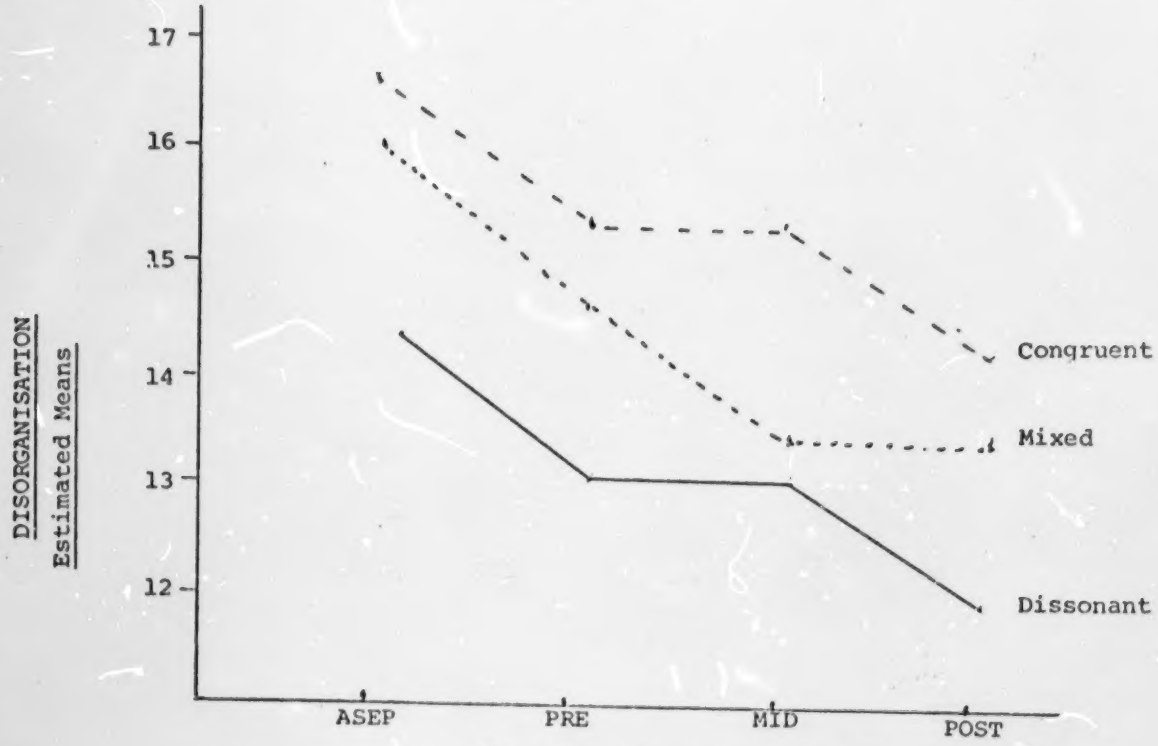

FIGURE 1.

TREATMENT X VALUES INTERACTION FOR DISORGANISATION

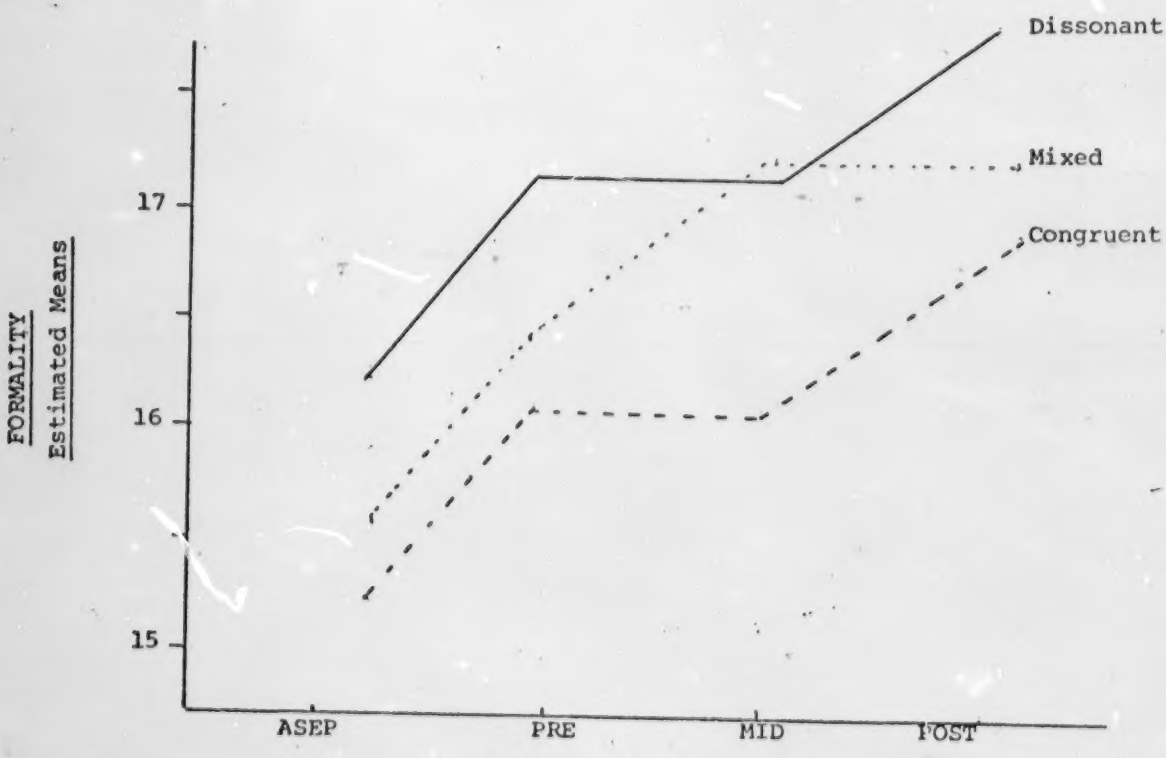

FIGURE 2.

TREATMENT X VALUES INTERACTION FOR FORMALITY

structuring by the teacher pupils perceived the classroom environment in less favourable terms, especially in relation to the amount of friction and disorganisation present. Post-structuring appears to be especially useful in improving pupils' perceptions.

To examine the effects of structuring on achievement, attitudes and satisfaction the data were analysed using MANOVA with the set of seven pre-tests listed above as covariates and the set of eight post-tests as the criteria. Values and treatments were assumed to be fixed effects. A summary of the analyses is presented in Table 4 and the associated univariate analyses in Table 5.

An overall examination of the results of the analyses, e.g. step-down results, univariate analyses and the estimated means for the post-tests after covariance adjustment reveals that the adjusted criterion variables most effected by variations among treatment-value cells were variables 13 and 14 which measured pupils' interest in their ASEP lessons and their perception of the amount they learned in relation to other science lessons. In general pupils in the groups experiencing some structuring and especially those in the post structuring one, expressed higher levels of interest and satisfaction than the ASEP only groups. The trend was similar for the perceived amount of learning.

Eliminating the interaction effects, the main effect for treatments was found to be significant ($p < .001$). Estimates of the effects for variables 13 and 14 reveal a clear trend:

post-structuring $>$ pre-structuring $>$ mid-structuring $>$ ASEP only

This finding for the superiority of post-structuring parallels those results in the researches by Bauman and Glass (1969) who found that post-organizers were somewhat more effective than pre-organizers and Wright (1969) who found that achievement gains were related to the extent to which teachers revised at the end of lessons.

(c) Variations and relationships in the environment

Relationships between the preceding set of pre-test measures and their pupils' perceptions of their learning environment were determined using canonical analysis. Table 6 shows the correlations between the original variables and the canonical variate, the canonical correlations and their probabilities for the two significant relationships found. The analyses indicate that:

(i) a cluster of pre-test variables including ability, prior knowledge and an interest in the existing science programme

TABLE 4. SUMMARY OF MANOVA RESULTS FOR VALUES X TREATMENT DESIGN WITH PRE-TESTS AS COVARIATES AND POST-TEST AS CRITERIA

Source	df	Multivariate F		Stepdown F	
		F	df	y13/y8-12	y14/y8-13
Constant (M)	1	-	-	-	-
Covariates (X)	6	9.35***	56,570	-	-
Values (A) elim. M,X	2	1.13	16,210	-	-
Treatments (B) elim.M,X,A	3	2.23**	24,305	9.86***	1.94
Interaction elim. M,X,A,B,	6	1.76**	48,521	5.76***	2.10*
Within groups	112				

* $p < .05$

** $p < .001$

*** $p < .0001$

TABLE 5. SUMMARY OF ANOVA RESULTS FOR VALUES X TREATMENTS DESIGN WITH POST-TEST MEASURES AS DEPENDENT VARIABLES, PRE-TEST AS COVARIATES

Post-test measure	F ratio		
	Values (2,112)[a]	Treatments (3,112)	Interaction (6,112)
Acht 1	1.51	1.42	.94
Acht 2	.59	.52	.65
Attit 1	.24	1.30	1.02
Attit 2	2.37	1.01	1.68
Attit 3	.08	.80	1.31
Satisf 1	2.78	12.03***	5.63***
Satisf 2	3.01	3.83 ✓	6.75***
Satisf 3	2.21	1.40	1.89

✓ $p < .05$

*** $p < .0001$

TABLE 6

Results of canonical analysis between pre-tests as predictors and perceptions of environment as criteria.

Variables	Structure coefficients Factor 1	Factor 2	Canonical Weights Factor 1	Factor 2
Predictors				
Inter D	48	73	26	60
Achievement 1	49	50	33	23
2	51	52	12	22
Attitude 1	18	05	-19	-02
2	28	06	04	09
3	31	16	-09	21
Interest in lessons	85	-45	87	-70
Criteria				
Cohesiveness	46	-06	31	07
Formality	04	-53	-15	-34
Goal direction	37	-48	-04	-29
Satisfaction	58	-54	32	-65
Disorganization	-51	-10	-19	-28
Apathy	-63	-09	-34	-30
Indifference	-64	07	-45	-02
Information Process	46	-06	20	09
Canonical R	60	48	Redundancy: Predictors given criteria 0.16	
Canonical R^2	36	23		
Probability	.0001	.0001	Criteria given predictors 0.06	

Note: Structure coefficients are correlations of original variables with canonical variates.

Only criteria with larger structure coefficients shown.

covaries with pupils' perceptions of the extent to which they were active and willing participants in well organised, enjoyable activities;

and

(ii) a cluster of pre-test variables including ability, prior knowledge and dissatisfaction with the existing programme covaries with pupils' perceptions of the extent to which the ASEP environment is seen as low in formality, goal direction and satisfaction.

This canonical analysis indicates that an individual's perception of the ASEP learning environment is not markedly influenced by his characteristics at the point of entry to the programme. The redundancy measure, though not an exceptionally good index according to some (e.g. Darlington et al, 1973), was only 0.06. Furthermore, inspection of the original correlation matrix revealed few correlations between an individual's pre-test and environmental measures which exceeded 0.3. On the other hand other analyses showed that the environment of a class was very much dependent on the entry characteristics of the class as a group. (Tisher and Power, 1975b).

A second canonical analysis was undertaken to examine the relationships between pupils' perceptions of the ASEP environment and individual outcome measures. Three significant canonical relationships were found (see Table 7). The first links a set of variables which measure individual's perceptions of the extent to which the classroom is a well-ordered one where pupils participate in interesting activities, achieve more highly, experience greater satisfaction with ASEP and have positive attitudes towards the environment. This link parallels the one referred to above between the pre-test measures and pupils' perceptions of the environment. These two sets of results taken together can be interpreted by assuming the existence of a "success syndrome" similar to that found operating in more conventional classroom settings (Power, 1971); viz, pupils who were able, achieving well and satisfied before ASEP was introduced, tend, after its introduction, to perceive the new environment as pleasant, enjoyable and one where they continue to succeed.

The other two canonical relationships were much more difficult to interpret, which is not surprising considering the low correlations between the original variables and the derived canonical variates. The second relationship seems to link the degree to which pupils perceive there is pressure on the class to "keep up" with their satisfaction with the ASEP approach. The third relationship seems to be between a greater cognitive press within the environment and the achievement of the cognitive and affective goals

TABLE 7

Results of canonical analysis between environment scales as predictors and post-test measures as criteria

Variables	Structure Coefficients Factor 1	Factor 2	Factor 3	Canonical weights Factor 1	Factor 2	Factor 3
Predictors:						
Cohesiveness	40	48	28	08	45	21
Formality	36	-08	-13	-17	17	-11
Speed	-01	36	-03	13	41	-06
Satisfaction	4[illegible]	10	-22	11	10	-35
Disorganisation	-64	16	08	-20	27	-15
Apathy	-75	06	15	-56	-03	13
Indifference	-60	18	00	-32	09	-01
Humour	23	-29	26	09	-13	17
Translation	25	06	28	16	-09	23
Information Process	34	-05	32	02	-36	36
Criteria:						
Achievement 1	71	-12	24	49	-04	06
Achievement 2	57	-23	48	18	-18	39
Attitude 1	39	44	37	-14	38	25
Attitude 2	43	36	10	16	28	-21
Attitude 3	58	-18	15	32	-64	-02
Satisfaction 1	74	38	-35	74	-14	-44
Satisfaction 2	50	57	-33	-15	43	-36
Satisfaction 3	39	65	34	-05	34	65
Canonical R	53	48	44	Redundancy:		
Canonical R^2	29	23	20	Predictors given criteria 0.06		
Probability	0001	0001	0004	Criteria given predictors 0.17		

* Note: Only predictors with larger structure coefficients shown.

at the expense of satisfaction with the content within the unit.

The preceding results were supplemented by information obtained from regression analyses to assess the contribution a knowledge of how an individual perceives his learning environment makes to explaining the variance in instructional outcomes, over and above that accounted for in terms of his entry characteristics. A series of regression analyses were conducted with the seven pre-test measures and 26 environmental measures (i.e. 15 LEI scales, 8 CAQ scales plus 3 additional scales) as predictors, and the eight post-test measures as criteria. In one set of analyses the pupil (N = 315) was taken as the unit of analysis whereas in the other set the unit was the class (N = 20)

Table 8 contains results from the first set of analyses and indicates that the addition of the environmental measures did not add significantly to the explained variation in achievement, attitudes towards the population explosion or towards the sensible use of resources. The LEI and CAQ measures made a small but significant contribution to the explained variation in attitudes towards pollution and in satisfaction with the ASEP approach. When partial correlations between the various environmental scales and outcomes (with pre-tests held constant) were calculated, the most consistent, though weak relationships (0.13 to 0.26) with residual outcomes were with cohesiveness, goal direction, satisfaction, favouritism and apathy. In the last instance significant relationships were negative. Thus, both individually and together the environmental measures contributed little to explaining the variance in achievements, attitudes and satisfactions of individuals studying the ASEP unit "How Many People" over and above that attributed to the pre-test measures.

Table 9 contains the results from the second set of regression analyses with the class as the unit of analysis. As there were only a small number of classes, the number of variables in the linear regression models were restricted to a maximum of three predictors at any one time. A similar procedure was followed to that described above: the eight post-test measures constituted the criteria and the seven pre-test measures, 26 environmental measures and the 36 behaviour measures (from SABIC) were the predictors.

The results indicate that most of the variance in pupil achievement (80%) can be accounted for by the pre-test measure, understanding of ecology. But, the extent to which the class was seen to be apathetic, diverse and involved in cramming contributes to the explained variation in achievement as do the frequencies of information giving, direction giving, and rest periods (i.e. no activity). The picture is somewhat different with respect to variation in attitude. The behaviour variables teacher-class interaction,

TABLE 8

General predictability of instructional outcomes from pre-test and environmental measures

Outcome Measure	Percent learning variance predictable			
	Pre-tests alone	Environment alone	Pre-tests + Env.	Increment due to Env.
Achievement:				
1. Ecology	32**	18**	40**	08
2. Population/ ecol.	35**	15**	41**	06
Attitude:				
1. Pollution	11**	14**	23**	12*
2. Population	14**	12	23**	09
3. Resources	21**	13*	27**	06
Satisfaction:				
1. Interest	10**	23**	27**	17**
2. Learning	04*	19**	22**	18**
3. Organization	05*	18**	21**	16**

* $p < .05$ ** $p < .01$

TABLE 9

Regression Analysis for Selected Perception, Behaviour and Outcome Measures (class as the unit)

Perception/ Behaviour Measure	Correlation		Proportion of Criterion Variance Explained					
			Achievement 1			Attitude 1		
	Ach^t	Attit.	a	b	c	a	b	c
SABIC categories								
Teacher-Class Interaction	-55	-56	80	81	01	28	49	22**
Teacher-Pupil Interaction	65	64	80	82	02	28	51	24**
No activity	-70	-54	80	87	07**	28	44	16*
Information Giving	37	35	80	85	05*	28	43	15*
Direction Giving	-58	-52	80	86	06*	28	48	20*
Perception Scales								
Participation	40	50	80	81	01	28	46	18*
Information Processing	55	61	80	81	01	28	50	22**
Cramming	57	27	80	84	04*	28	28	00
Cohesiveness	39	69	80	80	00	28	68	40**
Apathy	-55	-49	80	84	04*	28	40	12
Diversity	13	28	80	84	04*	28	30	02
Friction	-06	-26	80	81	01	28	46	18*
Goal Direction	09	41	80	80	00	28	54	26**
Favouritism	-23	-40	80	80	00	28	45	17*
Cliquishness	-02	-21	80	80	00	28	43	15*
Disorganisation	-33	-44	80	80	00	28	42	14*
Multiple - Criteria								
Cohes : cram	-	-	80	85	05	28	69	41**
T-C/No activ.	-	-	80	87	07*	28	56	28*
T-C/Inform.	-	-	80	85	05	28	56	28*
T-P/Direct.	-	-	80	86	06	28	53	25*

Note: (a) Variance accounted for by appropriate pre-test alone

(b) Variance accounted for by pre-test + behaviour/perception measure

(c) Increment due to behaviour/perception measure

* $p < 0.05$ ** $p < 0.01$ if increment significant

and teacher-pupil interaction, and the perception measures information processing, cohesiveness and goal direction, account for a substantial amount of the variation in attitude while rest periods, information and direction giving, participation, friction, favouritism, cliquishness and disorganization contribute to a smaller, but still significant extent. Note that a number of regression models which included two behaviours or perceptions were set up. The results from a few are reported in Table 9 but none of these proved to be significantly better than the preceding set which contained only one behaviour or perception measure.

To recapitulate: whereas pupils' understanding of ecology was dependent on the frequency of 'rest periods' (no activity) their attitude towards environmental issues was dependent on the amount of teacher to class and teacher to pupil interaction which occurred as well as the extent to which the class was seen to be cohesive, goal-directed and involved in information processing. On the other hand, in those classes rated high on 'rest-periods', direction giving, friction, favouritism, cliquishness and disorganisation, the pupils' attitudes towards the environment were less likely to change towards those being encouraged in the ASEP unit.

Concluding Comments

The studies reported in this paper provide evidence that the introduction of self-paced curriculum materials into learning environments where they had not previously been used does produce changes in the pupils' perceptions of their environments and in the manner in which these function even when the teachers' beliefs about effective teaching are dissonant to the approach adopted by the materials. Certainly when there is a mis match between the teacher's approach and that of the materials, pupils are not significantly disadvantaged either cognitively or affectively, other things being equal. However, adding some structure to lessons does help, especially in those classes where teachers do not value the new approach. But, then, with this last group a freer environment does result in a favourable development of interest in science by the pupils. Whereas pupils' entry characteristics do not markedly effect their perceptions of the new learning environment, a success syndrome operates: those who previously enjoyed the lessons and succeeded continue to do so in the new settings. Furthermore a number of environmental variables, including apathy, diversity, information-giving and rest periods contribute to variations in achievement while some of these and others such as cohesiveness, goal-direction, friction, cliquishness and disorganization contribute much more to variations in attitude towards environmental issues. There are, in fact, some intriguing and fascinating associations among the various environmental variables and outcome measures.

This report, whilst not definitive on its own, when combined with others contributes to the large and exciting task of enhancing our understanding of that polymorphous enterprise teaching.

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